



**Technical Report Series on the
Biosystem-Aerosphere Study (BOREAS)**

William J. Shuttleworth and David E. Knapp, Editors

216

**NASA TF-11 SSA-Fen
Flux Data**

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**Technical Report Series on the
Boreal Ecosystem-Atmosphere Study (BOREAS)**

Forrest G. Hall and David E. Knapp, Editors

Volume 216

**BOREAS TF-11 SSA-Fen
Soil Surface CO₂ Flux Data**

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BOREAS TF-11 SSA-Fen Soil Surface CO₂ Flux Data

Timothy J. Arkebauer

Summary

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. These data are soil surface CO₂ flux data at the SSA-Fen site from 27-May-1994 to 23-Sep-1994 and from 13-May-1995 to 03-Oct-1995. A portable gas exchange system was used to make these measurements. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-11 SSA-Fen Soil Surface CO₂ Flux Data

1.2 Data Set Introduction

The Tower Flux (TF)-11 team collected soil surface CO₂ flux data at the BOREal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA)-Fen site in 1994 and 1995. A portable gas exchange system was used to make these measurements.

1.3 Objectives/Purpose

The objective of these measurements was to evaluate the soil surface CO₂ flux and characterize its response to controlling variables (e.g., temperature, water content, water table depth).

1.4 Summary of Parameters

Each data record includes the date and time of measurements, surface CO₂ flux, and environmental conditions (air temperature, soil temperature, CO₂ concentration, relative humidity, and air vapor pressure).

1.5 Discussion

The overall project goal was to investigate the surface-atmosphere exchange of carbon dioxide and methane, and the associated energy fluxes, at the SSA-Fen site. The exchange of CO₂ at the soil surface is an important component of the overall surface-atmosphere CO₂ exchange. It is related to soil (peat) decomposition processes, long-term carbon storage, and, perhaps more indirectly, canopy photosynthesis.

1.6 Related Data Sets

BOREAS TF-11 SSA-Fen Tower Flux and Meteorological Data
BOREAS TF-11 SSA-Fen Leaf Gas Exchange Data
BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data
BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Timothy J. Arkebauer, Associate Professor
Department of Agronomy
University of Nebraska-Lincoln

Dr. Shashi B. Verma, Professor
Department of Agricultural Meteorology
University of Nebraska-Lincoln

2.2 Title of Investigation

Field Micrometeorological Measurements, Process-Level Studies and Modeling of Methane and Carbon Dioxide Fluxes in a Boreal Wetland Ecosystem

2.3 Contact Information

Contact 1:

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Contact 2:

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Raytheon ITSS
NASA GSFC
Code 923
Greenbelt, MD 20771
(301) 286-1424
(301) 286-0239 (fax)
David.Knapp@gssc.nasa.gov

3. Theory of Measurements

Surface CO₂ flux measurements were made by using an LI-6200 system in the closed-circuit mode. An LI-6000-09 Soil Respiration Chamber was used with the system. The CO₂ flux is calculated via the change in CO₂ concentration in the sample chamber with time. Further details can be found in the LI-6200 Technical Reference Manual (LI-COR, Inc., 1990). Additional information on the general theory related to gas exchange measurements can be found in Ball (1987).

4. Equipment

4.1 Instrument Description

The measurements were made with an LI-6200 Portable Photosynthesis System outfitted with an LI-6000-09 Soil Respiration Chamber. The chamber volume is approximately 1-liter, and it covers 83 cm² of the soil surface.

4.1.1 Collection Environment

All measurements were made under ambient environmental conditions in the field at the SSA-Fen site.

4.1.2 Source/Platform

Measurements were made from platforms or boardwalks raised approximately 0.2 m above the fen surface.

4.1.3 Source/Platform Mission Objectives

None given.

4.1.4 Key Variables

Soil surface CO₂ flux, soil temperature, air temperature, air vapor pressure, air CO₂ concentration, distance between soil surface and water table.

4.1.5 Principles of Operation

The LI-6200 was operated in the closed mode. Surface CO₂ fluxes were determined from the time rate of change of CO₂ concentration in the LI-6000-09 chamber. CO₂ concentrations are measured with an infrared gas analyzer (IRGA). A pump circulates the air from the respiration chamber, through the analyzer, and back into the chamber. Water vapor concentrations in the sample chamber are determined by a Vaisala humidity chip and a thermistor sensing the air temperature. Soil temperatures are determined by a thermocouple pair that measures the temperature difference between the air thermistor and a thermocouple inserted 10 cm below the soil surface.

Additional information is found in the LI-COR LI-6200 Technical Reference manual, the LI-COR LI-6000-09 Soil Respiration Chamber instruction manual, and Norman et al. (1992).

4.1.6 Sensor/Instrument Measurement Geometry

The measurements were made with an LI-6200 Portable Photosynthesis System outfitted with an LI-6000-09 Soil Respiration Chamber. The chamber volume is approximately 1-liter, and it covers 83 cm² of the soil surface.

4.1.7 Manufacturer of Instrument

LI-COR, Inc.
P.O. Box 4425
4421 Superior Street
Lincoln, NE 68504 USA
(402) 467-3576
(402) 467-2819 (fax)

4.2 Calibration

4.2.1 Specifications

The IRGAs, the humidity chips, the flow meters, and the quantum sensors were calibrated by the manufacturer prior to each field season. The zero and span of the LI-6200 CO₂ analyzer were calibrated against known standard gases in the field.

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

Annual calibration of the IRGAs, the humidity chips, the flow meters, and the quantum sensors were done by the manufacturer. Daily calibration of the zero and span of the IRGAs was done in the field. The CO₂ zero and the flow meter zero were checked and adjusted several times daily.

4.2.3 Other Calibration Information

Calibration gases for the IRGAs were obtained from:

Acklands
1042 Quebec Ave.
Saskatoon, Saskatchewan CANADA, S7K 1V5
(Primary supplier: Linde gas, Alberta, CANADA)

These gases were calibrated against gases of known concentration traceable to the National Oceanic and Atmospheric Administration (NOAA), Boulder, CO.

5. Data Acquisition Methods

The surface CO₂ fluxes were measured at 48 collar locations (see Section 7.1.1). These collars were positioned in early May each year and were not moved during the growing season. When the water table covered a collar, the measurement was made at the water surface above the collar.

For each surface flux determination, the LI-6000-09 chamber was first positioned atop the polyvinylchloride (PVC) collar such that a good seal was obtained. A tripod was used to hold the chamber in position. Fluxes were determined from the change of CO₂ concentration inside the closed system. Care was taken to determine fluxes when the CO₂ concentration in the chamber was near ambient (ca. 350 ppm); at times this meant drawing down the system CO₂ concentration by using the LI-6200 soda lime scrubber. Once the chamber was in place, individual measurements took about 1 minute to complete.

A negative surface CO₂ flux (e.g., soil respiration) indicates that the net flux of CO₂ is from the soil into the atmosphere.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

A limited set of field notes and observations is available by request from T.J. Arkebauer (see Section 2.3).

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The SSA-Fen is a "patterned" fen with a heterogenous surface. Areas of open water alternate with 2- to 20-cm-tall hummocks composed of more or less consolidated vegetation. Larger features include strings, where the peat surface is about 20-50 cm above the water table, and flarks, which are more extensive areas of open water. We attempted to characterize the variability in the surface CO₂ flux associated with these microtopographic features as well as to obtain estimates of the surface CO₂ flux in the vicinity of the micrometeorological tower.

In mid-August 1993, two permanent boardwalks were laid out about 200 m north and south of the main (eddy correlation) boardwalk. Twelve measurement platforms were erected along each boardwalk to allow us access to the fen surface without standing on it. Six of these platforms (N1, N₂, S1, S2, S5, and S6) were located on obvious (i.e., large) strings. (Note that these larger strings were, for the most part, absent from the "micrometeorological footprint" sensed by the eddy correlation sensors.) All the 1994 and 1995 surface flux data were obtained adjacent to these platforms. Platforms N3, N4, N5, N6, S3, and S4 were judged to be most representative of the micrometeorological tower footprint. These six platforms were all located in extensive areas of *Betula pumila*. The surface here consisted of sedge (*Carex* sp.) hummocks interspersed with open water where *Menyanthes trifoliata* was common.

At the beginning of each season, 48 PVC collars (about 10 cm in diameter and 10 cm long) were placed near the 12 access platforms (four at each platform). Each of the four were positioned so that one collar was in a low spot, one was on a high spot, and two were in between. As the water table position changed during the season, the collars were alternately inundated and exposed.

The SSA-Fen tower was located at the following North American Datum of 1983 (NAD83) coordinates:

Latitude	Longitude	BOREAS_X	BOREAS_Y	UTM Northing	UTM Easting
53.80206°N	104.61798°W	419.527	330.991	5961566.6	525159.8

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

Each measurement represents the flux at a 10-cm-diameter area near the SSA-Fen tower site.

7.1.4 Projection

These data were collected at point locations.

7.1.5 Grid Description

None.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Measurements were made from 27-May-1994 to 23-Sep-1994 and from 13-May-1995 to 03-Oct-1995.

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

Measurements were taken at multiple times during the growing seasons.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

Column Name

SITE_NAME
SUB_SITE
DATE_OBS
TIME
INSTRUMENT_NUM
CHAMBER_AREA
SYSTEM_VOLUME
PLATFORM
PLATFORM_REP
WATER_TABLE_HGT
CHAMBER_ID
DIST_H2O_TABLE
OBS_NUM
SOIL_TEMP_10CM
AIR_TEMP_CHAMBER
CO2_CONC
AIR_FLOW_CHAMBER
REL_HUM_CHAMBER
VAPOR_PRESS_CHAMBER
CO2_FLUX
CRTFCN_CODE
REVISION_DATE

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
TIME	The Greenwich Mean Time (GMT) when the data were collected.
INSTRUMENT_NUM	The instrument number used for the measurement. If = 6400, the LI-COR 6400 was used. Otherwise, the LI-COR 6200 was used and the number indicates the LI-COR 6200 file number.
CHAMBER_AREA	The total area covered by the respiration chamber.
SYSTEM_VOLUME	The total system volume of the equipment used to measure flux.
PLATFORM	The object (e.g., satellite, aircraft, tower, person) that supported the instrument.
PLATFORM_REP	The platform representation where 0 means that the platform is representative of the micrometeorological footprint and 1 means that the platform is representative of the larger strings in the fen.
WATER_TABLE_HGT	Water table height above a reference surface.
CHAMBER_ID	Identifier assigned to the chamber measured.
DIST_H2O_TABLE	The distance between the surface inside the collar and the water table.
OBS_NUM	The observation number.
SOIL_TEMP_10CM	Soil temperature at a depth of 10 cm.
AIR_TEMP_CHAMBER	The temperature of the air in the chamber.
CO2_CONC	CO2 concentration.
AIR_FLOW_CHAMBER	The total air flow rate through the system.
REL_HUM_CHAMBER	The relative humidity of the air in the chamber.
VAPOR_PRESS_CHAMBER	Vapor pressure of the air in the chamber.
CO2_FLUX	Carbon Dioxide flux.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME	[HHMMSS GMT]
INSTRUMENT_NUM	[unitless]
CHAMBER_AREA	[millimeters ²]
SYSTEM_VOLUME	[millimeters ³]
PLATFORM	[none]
PLATFORM_REP	[none]
WATER_TABLE_HGT	[millimeters]
CHAMBER_ID	[none]
DIST_H2O_TABLE	[millimeters]
OBS_NUM	[unitless]
SOIL_TEMP_10CM	[degrees Celsius]
AIR_TEMP_CHAMBER	[degrees Celsius]
CO2_CONC	[parts per million]
AIR_FLOW_CHAMBER	[micromoles] [second ⁻¹]
REL_HUM_CHAMBER	[percent]
VAPOR_PRESS_CHAMBER	[millibars]
CO2_FLUX	[micromoles] [meter ⁻²] [second ⁻¹]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS.]
SUB_SITE	[Assigned by BORIS.]
DATE_OBS	[Supplied by Investigator.]
TIME	[Supplied by Investigator.]
INSTRUMENT_NUM	[Supplied by Investigator.]
CHAMBER_AREA	[Supplied by Investigator.]
SYSTEM_VOLUME	[Supplied by Investigator.]
PLATFORM	[Supplied by Investigator.]
PLATFORM_REP	[Supplied by Investigator.]
WATER_TABLE_HGT	[Supplied by Investigator.]
CHAMBER_ID	[Supplied by Investigator.]
DIST_H2O_TABLE	[Supplied by Investigator.]
OBS_NUM	[Supplied by Investigator.]
SOIL_TEMP_10CM	[Supplied by Investigator.]
AIR_TEMP_CHAMBER	[Supplied by Investigator.]
CO2_CONC	[Supplied by Investigator.]
AIR_FLOW_CHAMBER	[Supplied by Investigator.]
REL_HUM_CHAMBER	[Supplied by Investigator.]
VAPOR_PRESS_CHAMBER	[Supplied by Investigator.]
CO2_FLUX	[Supplied by Investigator.]
CRTFCN_CODE	[Assigned by BORIS.]
REVISION_DATE	[Assigned by BORIS.]

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-FEN-FLXTR	SSA-FEN-FLXTR	None	None	None	None
SUB_SITE	9TF11-SSC01	9TF11-SSC01	None	None	None	None
DATE_OBS	27-MAY-94	03-OCT-95	None	None	None	None
TIME	14200	234518	None	None	None	None
INSTRUMENT_NUM	1	695	None	None	None	None
CHAMBER_AREA	7100	8300	None	None	None	None
SYSTEM_VOLUME	989900	1458000	-999	None	None	None
PLATFORM	N1	S6	None	None	None	None
PLATFORM_REP	0	1	None	None	None	None
WATER_TABLE_HGT	35	287	-999	None	None	None
CHAMBER_ID	0	9	None	None	None	None
DIST_H2O_TABLE	0	330	-999	None	None	None
OBS_NUM	1	3	None	None	None	None
SOIL_TEMP_10CM	.838	22.63	-999	None	None	None
AIR_TEMP_CHAMBER	5.703	33.03	None	None	None	Blank
CO2_CONC	331.7	524.4	None	None	None	None
AIR_FLOW_CHAMBER	226.7	1228	None	None	None	None
REL_HUM_CHAMBER	3.69	98.5	None	None	None	None
VAPOR_PRESS_CHAMBER	1.608	24.91	None	None	None	None
CO2_FLUX	-28.43	.2218	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	01-APR-99	01-APR-99	None	None	None	None

Minimum Data Value -- The minimum value found in the column.

Maximum Data Value -- The maximum value found in the column.

Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.

Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.

N/A -- Indicates that the value is not applicable to the respective column.

None -- Indicates that no values of that sort were found in the column.

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

```
SITE_NAME, SUB_SITE, DATE_OBS, TIME, INSTRUMENT_NUM, CHAMBER_AREA, SYSTEM_VOLUME,  
PLATFORM, PLATFORM_REP, WATER_TABLE_HGT, CHAMBER_ID, DIST_H2O_TABLE, OBS_NUM,  
SOIL_TEMP_10CM, AIR_TEMP_CHAMBER, CO2_CONC, AIR_FLOW_CHAMBER, REL_HUM_CHAMBER,  
VAPOR_PRESS_CHAMBER, CO2_FLUX, CRTFCN_CODE, REVISION_DATE  
'SSA-FEN-FLXTR', '9TF11-SSC01', 27-MAY-94, 230757, 4, 8300, -999, 'N1', 1, -999.0, '2',  
-999, 1, -999.0, 28.26, 359.1, 1014.0, 21.33, 8.189, -.5404, 'CPI', 01-APR-99  
'SSA-FEN-FLXTR', '9TF11-SSC01', 27-MAY-94, 231537, 5, 8300, -999, 'N1', 1, -999.0, '2',  
-999, 1, -999.0, 28.07, 358.8, 1010.0, 25.82, 9.803, -.8599, 'CPI', 01-APR-99
```

8. Data Organization

8.1 Data Granularity

The smallest amount of data that can be ordered from this data set is a day's worth of data for a given site.

8.2 Data Format

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

Formulae for calculating the CO₂ flux rates are given in the LI-6200 Technical Reference Manual.

9.1.1 Derivation Techniques and Algorithms

None given.

9.2 Data Processing Sequence

9.2.1 Processing Steps

- The BOREAS Information System (BORIS) received data from TF-11.
- BORIS standardized the units and loaded data into the data base.
- BORIS extracted data from database into ASCII files.

9.2.2 Processing Changes

None.

9.3 Calculations

None.

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

None.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

Calibration drift: The flow meter zero and IRGA CO₂ zero exhibited occasional drifts. The zeros were set periodically throughout the day.

10.2 Quality Assessment

None given.

10.2.1 Data Validation by Source

None given.

10.2.2 Confidence Level/Accuracy Judgment

None given.

10.2.3 Measurement Error for Parameters

None given.

10.2.4 Additional Quality Assessments

None given.

10.2.5 Data Verification by Data Center

BORIS staff loaded the data into the data base and checked for any inconsistencies during loading.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems With The Data

There were problems with the soil thermocouple probes used in 1994. All 1994 soil temperatures are indicated as missing values. The difficult-to-interpret 1994 soil temperatures may be available by special request from T.J. Arkebauer.

11.3 Usage Guidance

The normal caveat of 'use at your own risk' applies. Correspondence with T.J. Arkebauer is encouraged when questions arise. A negative surface CO₂ flux (e.g., soil respiration) indicates that the net flux of CO₂ is from the soil into the atmosphere.

11.4 Other Relevant Information

Dr. Evan C. Jolitz was responsible for much of the day-to-day coordination of the field measurements. Mr. Shawn Stevens and Mr. Tommi Peltovuori assisted in data collection in 1994. Their assistance is greatly appreciated. We also thank LI-COR, Inc., for their generous contribution of various prototypes of the LI-6000-09 respiration chambers.

12. Application of the Data Set

These data can be used to better understand the soil CO₂ flux at a typical fen in the boreal forest.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

None given.

14.2 Software Access

None given.

15. Data Access

The SSA-Fen soil surface CO₂ flux data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornl daac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics
<http://www-eosdis.ornl.gov/>.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [<http://www-eosdis.ornl.gov/>] and the anonymous FTP site [<ftp://www-eosdis.ornl.gov/data/>] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Data Processing Documentation

LI-6200 Technical Reference Manual. March 1990. LI-COR, Inc., Lincoln NE, USA.

LI-6000-09 Instruction Manual, November 1993. LI-COR, Inc., Lincoln NE, USA.

17.2 Journal Articles and Study Reports

Ball, J.T. 1987. Calculations related to gas exchange. In: Stomatal Function. E. Zeiger, G.D. Farquhar, and I.R. Cowan (eds.). Stanford University Press, Stanford, CA, pp. 446-475.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Norman, J.M., R. Garcia, and S.B. Verma. 1992. Soil surface CO₂ fluxes and the carbon budget of a grassland. *Journal of Geophysical Research* 97(D17): 18,845-18,853.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. *Bulletin of the American Meteorological Society*. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. *Journal of Geophysical Research* 102(D24): 28,731-28,770.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only-Memory
DAAC	- Distributed Active Archive Center
DOY	- Day of the Year
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
IRGA	- Infrared Gas Analyzer
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NOAA	- National Oceanic and Atmospheric Administration
NSA	- Northern Study Area
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
PPMV	- Parts Per Million by Volume
PVC	- Polyvinylchloride
SSA	- Southern Study Area
TF	- Tower Flux
URL	- Uniform Resource Locator

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